# EQUIPMENT FOR SANITARY LANDFILL OPERATIONS

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PREPARED BY:

JAMES M. LAPP

ALBERTA ENVIRONMENT

POLLUTION CONTROL DIVISION

WASTE MANAGEMENT BRANCH

# INTRODUCTION

As very few publications have been written which deal entirely with sanitary landfill equipment, the information on the following pages was written to help fill this void.

Information most readily available is obtained from publications dealing with the whole subject of sanitary landfills. This usually gives only a general introduction into equipment.

Other information is available through equipment manufacturers. Although manufacturers are very informative, opinions can be somewhat varied.

A vast and most important source of information is available through the equipment operators themselves. They know better than anyone the abilities and inabilities of their own individual machine.

In many instances people investigating landfill equipment do not have the information readily available. It is intended that the next few pages be used to introduce these persons to the equipment commonly used in Alberta.

It is hoped that the reader will draw some conclusions as to the type of equipment best suited to his own sanitary landfill.

It is suggested that the reader also seek information from the sources previously mentioned.

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## EQUIPMENT FOR SANITARY LANDFILL OPERATIONS

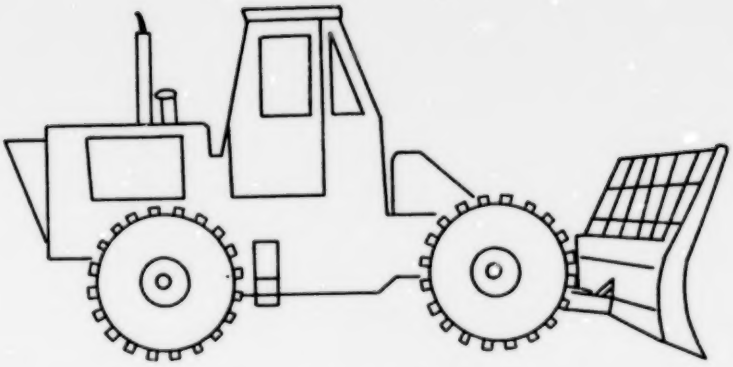
Various types of equipment are available for sanitary landfill operations. General operations require machines for excavation, spreading and compacting refuse, placement, spreading and compaction of cover material and site maintenance. Equipment is also required for fire control, dust control and clean-up.

There are five basic types of landfill equipment with varying degrees of limitations and versatility. Selection of this equipment depends upon various conditions (e.g. operating conditions, soil composition, refuse composition, volume of waste disposal, etc.)

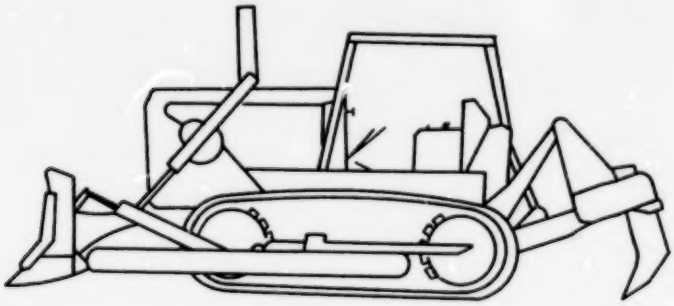
The following are the most common types of equipment used in Alberta.

1. Steel wheeled compactors
2. Track-type tractors
3. Track-type loaders
4. Wheel type loaders
5. Wheel tractor scrapers

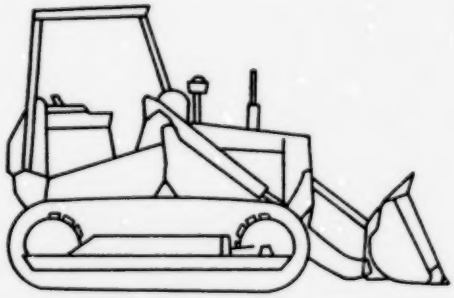
Each type of equipment has to be dealt with individually to determine suitability of the machine for each individual site.



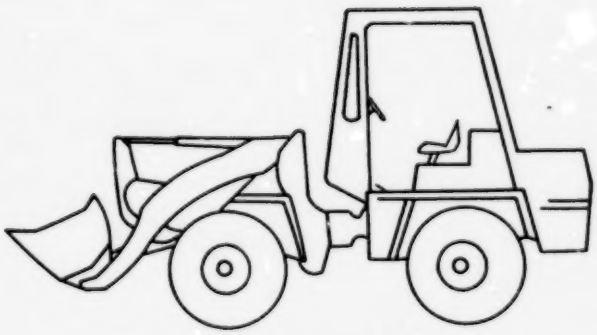
STEEL WHEELED COMPACTOR



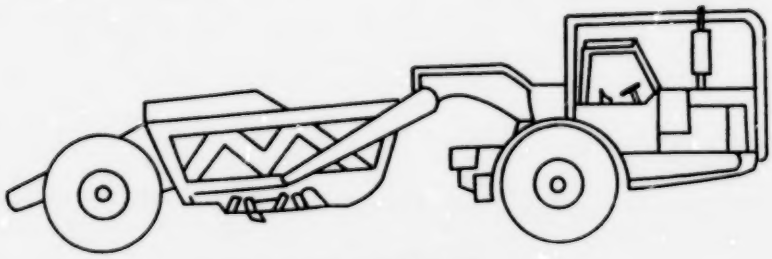
TRACK TYPE TRACTOR



TRACK TYPE LOADER



RUBBER TIRED LOADER



WHEEL TRACTOR SCRAPER

## Steel Wheeled Compactors

### General

Steel wheeled compactors are designed specifically for compacting solid wastes. Most are designed from basic wheel loader chassis or road compactors. Wheels are studded with load concentrators of various designs. Different makes and models have varying operational abilities.

### Advantages

- Greater compaction than other equipment types
- Excellent for spreading refuse and cover material
- Will crush bulky items
- Breaks up trash, wood, and glass
- Fewer mechanical breakdowns due to build up of materials in drive train
- Less blowing of papers after compaction

### Disadvantages

- Poor for excavation purposes
- Does not have good traction on steep slopes or when excavating
- Wheels may clog with refuse or soil
- Compacted surface may require blading to provide drainage
- Numerous passes to provide smoother surface

### Attachments

- *R.O.P.S. required for operator safety
- Enclosed operating compartment - for operator comfort
- Air-conditioning - for operator's comfort - optional

- Oscillation of wheels - depends upon machine make
- Steel wheel drums or encasement of rubber tires
- Cleaning bars or self cleaning compaction feet
- Loader type or dozer type front end

*Roll over protection structure.

Summary

With contact pressures of up to 4,000 p.s.i., this equipment gives maximum compaction of solid wastes in sanitary landfills. This, in turn, will reduce land requirements.

Steel wheeled compactors are best suited to medium or large sanitary landfills. Variations of attachments may give added versatility required in small one-machine operations.

It must be noted that this equipment is best used on a level, even surface and will not perform as well as tracked equipment on steep slopes or wet conditions. These machines are not designed for excavation purposes.

Steel wheeled compactors' versatility is limited to spreading and compacting of solid waste and cover material. This requires the use of a second machine, be it full-time or part-time for excavation of cover material.

A loader type front end blade will add to the versatility of these machines. This type of equipment will allow excavation and carrying of light soils for cover material (e.g. sandy loams as in Wetaskiwin).

Material may also be carried from loosely piled stockpiles of heavier soils (e.g. clay soil in Camrose).

Cleaning bars or self-cleaning feet are required as clogging of wheels reduces traction and compactive forces. Cleaning bars may be preferred in highly cohesive soils (e.g. Pincher Creek Regional Landfill), while self-cleaning feet may be adequate in less cohesive soils (e.g. Lethbridge Sanitary Landfill). In situations where the machine is operated primarily on refuse, self-cleaning feet may be adequate (e.g. Calgary Sanitary Landfills).

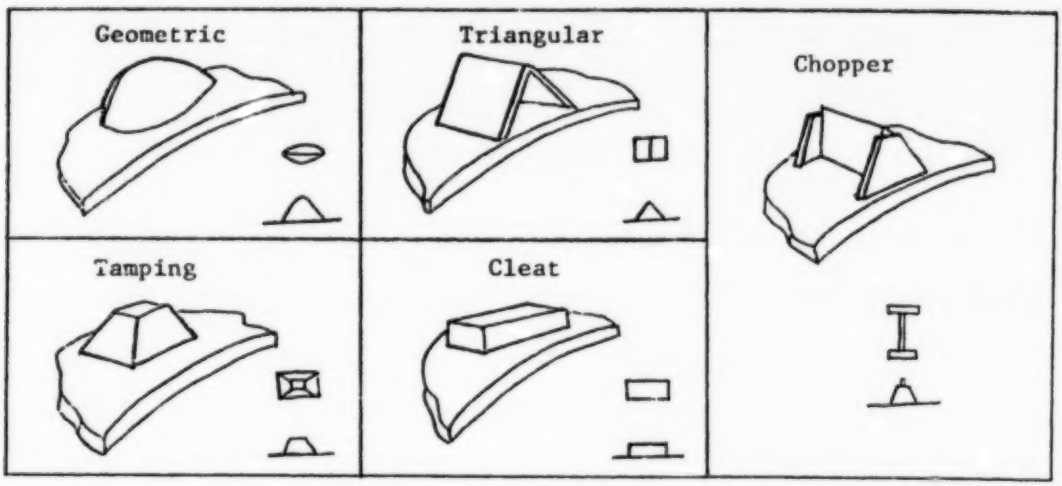
Oscillation of wheels or axles appears to be an individual preference. Oscillation may reduce pitching or rolling action on rough terrain associated with small working face areas and slopes. With a larger working face, terrain somewhat more even or flat, non-oscillation may be preferred.

Manoeuverability, which depends upon turning radius and speed, varies with each individual machine. Larger sites may require speed over turning ability, while smaller sites may require a shorter turning radius.

Compaction feet vary in design and may dictate working conditions. For example; tamping type feet are limited to 10:1 slopes as those encountered in trench type landfills. V-cleats are limited to 5:1 slopes found either in trench type or area type landfills. Chopper

blades will work on slopes up to 3:1 as those in area type landfills with cell construction.

Of the three basic types mentioned, each has its own variations. Periodic repair and build up of compaction feet of all types is required to maintain compacting ability.




## Track Type Tractors

### General

Track-type tractors or crawler dozers are designed for floatation and traction. They are primarily used for push or pull operations.

### Advantages

- Economically move earth up to 300'
- Work well on steep slopes
- Excellent for spreading solid waste and cover material

- Excellent for excavating
- Most versatile equipment available
- Excellent traction on wet ground
- More even compaction and compaction surface

Disadvantages

- Densities of compacted waste are lower than steel-wheeled compactors
- Build up of wire and trash in tracks results in high maintenance cost
- Difficulty compacting bulky items
- More blowing of papers than with steel wheeled compactors

Attachments

- R.O.P.S. required for operator safety
- Enclosed operating compartment - optional - not always available
- Air conditioning - optional
- Single or double grouser tracks
- Tractor drawn scraper - adds versatility
- Ripper tooth - adds versatility in frost or consolidated soils
- U-shaped sanitary landfill blade

Summary

Track-type tractors are essentially the most versatile of all available equipment. Cover material can be moved distances of up to 300 feet economically. These machines are excellent for excavation of trenches and stockpiling. With a tractor drawn scraper, earth may be excavated and hauled up to 1000 feet in distance.

Track-type tractors may also be utilized for site preparation and finishing as well as road construction and maintenance.

Ripper attachments are available and can increase usefulness in frost conditions or in consolidated soil.

These machines work well in wet conditions due to higher traction. Also spreading of waste on steep slopes with up-hill push is more effective than with wheel type equipment.

Track guiding guards should be considered to control sidewear on links, sprockets, and rollers. In addition, they may reduce the clogging of refuse in the undercarriage. "Holes" cut in pads may help prevent garbage and dirt accumulating and tightening tracks. Operator skill will also reduce maintenance costs. The versatility of a crawler tractor may far outweigh track maintenance requirements.

Narrow tracks are more benifical as they 1) increase compaction, 2) reduce turning resistance, 3) reduce uneven loading of undercarriage, 4) reduce bending of individual shoes.

Single grouser shoes 1) help increase the compaction effort, 2) increase traction, 3) and reduce clogging of dirt and solid wastes. However, increased turning resistance and drive train stresses result. Because of this they may not be available or may not be recommended.

Large bulky items are difficult to compact. A bulky object may be crushed on a solid level surface then pushed to the toe of the working face. It may be more practical to store these items elsewhere on the

site for salvaging. Rubber tires also create problems, but they are also a problem with any other equipment and should be segregated for reuse rather than be buried.

## Track Type Loaders

### General

Track-type loaders or crawler loaders are designed similar to track-type dozers. Instead of a push blade, they are equipped with a bucket used for digging and carrying materials.

### Advantages

- Economically move earth up to 300 feet
- Excellent for excavating
- Good cover and solid waste spreading ability
- Extremely versatile
- Excellent traction on wet ground and steep slopes

### Disadvantages

- Less compaction of solid waste
- Clogging of refuse in tracks
- Difficulty in compacting bulky items
- Blowing papers after compaction

### Equipment

- Landfill bucket - dozing and excavation capabilities
- R.O.P.S. - required for operator safety
- Enclosed operating compartment
- Air conditioning - optional

- Single or double grouser shoes
- Multi-purpose buckets
- Quick Couplers

Summary

Track-type loaders are similar to track-type dozers in versatility. They have the added ability of lifting and carrying soil without losing excavating and spreading ability. Also with a clamshell bucket, objects may be separated. These machines are not equipped to pull scrapers, limiting hauling to short distances.

It has been found that stockpiling cover material with loader leaves soil in a loose state. This results in easier excavation from stockpiles in frost conditions.

In general, the limitation of tracked loaders and available optional equipment are similar to those previously mentioned for tracked dozers.

## Wheel Type Loaders

Wheel type loaders or pneumatic tired loaders are designed for speed and mobility. These machines are, in most cases, four wheel drives.

Advantages

- Speed
- Mobility
- Versatility

- Good spreading capabilities
- Good compaction of solid wastes

Disadvantages

- Traction is poor in poor underfoot conditions
- Excavation ability is limited
- Extra wear on drive train
- Work poorly on steep slopes
- Tire wear is excessive due to corrosion and punctures
- Unable to compact bulky items

Equipment

- Quick coupler and various front end attachments adds to versatility
- R.O.P.S. - recommended for operator safety
- Enclosed operator compartment
- General purpose bucket
- Multi-purpose bucket

Summary

Wheel type loaders may be useful in small landfills as a part-time machine. With a quick coupler, an operator can change attachments in as little time as 30 seconds. With this, an operator can change from a landfill dozer blade to a bucket for excavation, then to various other attachments for in-town work.

Excavation ability depends upon soil type involved. This machine may be effective in light soils and may be virtually ineffective in very

heavy soils. Material, once excavated, can be moved up to 600 feet, but it must be remembered that excessive loads and bouncing of bucket creates extra pressures on the hydraulic system.

Bulky items cannot be crushed with this equipment. Because of this, large items would have to be disposed of by other means.

Although higher ground pressures result in higher compaction densities of general refuse than that achieved with track-type equipment, this difference does not outweigh operating capabilities.

Rubber tires provide the advantage of being able to move equipment on roadways, but it is recommended that tires be urethane foam filled to eliminate flat tires.

Wheel type loaders may be more effective when used as a second machine either full-time or part-time, and depending upon local conditions.

## Wheel Tractor Scrapers

Wheel tractor scrapers are designed for moving large amounts of material with a reasonable rate of speed over distances greater than 1,000 feet.

### Advantages

- Suited for hauling long distances
- Good excavating capabilities
- Excellent spreading capabilities

Disadvantages

- Versatility limited to only one purpose
- Difficulty of maintaining haul roads in some areas
- Compacts soil in stockpiles upon dumping.

Equipment

- Single engine unit - works in loam and damp soils
  - requires push tractor for loading
- Tandem powered unit - operates with two engines for four wheel drive
  - works well in clay, wet soil
  - may still require push tractor
- Elevating scraper - self loading
  - works well in various conditions

Summary

Due to limited versatility, wheel tractor scrapers are practical only in very large landfills, or as a part-time machine. In many cases these machines are used only for excavation and stockpiling and/or final cover placement. Some municipalities contract this work to others.

With trench-type landfills, these machines are commonly used. Trenches are excavated and material is stockpiled to the sides. But, because soil is compacted, frost becomes a problem in winter operations. Other equipment, such as draglines or loaders may be considered if such a problem interferes with normal operations.

## Draglines and Backhoes

These machines were designed to excavate and stockpile soil. They are primarily used in trenching and open pit types of operations.

### Advantages

- Excellent for excavating most soils
- Work well in poor underfoot conditions
- Stockpile soil in a large state

### Disadvantages

- Slow for large excavations
- Move soil limited distances
- Only one purpose

### Equipment

Draglines operate with cables and a boom. These machines are relatively slow, but are capable of long reaches.

Backhoes operate by hydraulics on a boom. They are primarily used for trench excavations and have a limited reach.

### Summary

For application in landfills, these machines may be used very effectively to stockpile soil in a loose state for ease of winter operations.

Often they are used in conjunction with scrapers, where the scrapers will excavate the central portion of a trench and the dragline

or backhoe will excavate the edges. This combination gives an increase in the speed of excavation.

In very large operations, draglines may be used as an everyday machine, such as the City of Calgary where one dragline is used for excavations for three different sanitary landfills.

For small operations, they are only hired for the initial site development.

## General Equipment Requirements

The types and numbers of equipment required are related to the incoming waste volume and the operational plan of the sanitary landfill. Also local soil conditions and weather conditions have a bearing on equipment selection.

Equipment which is too small will require more maintenance and more operating hours. Periodically supplemental equipment may be required to help in adverse weather conditions or times of heavier waste flow.

Stand-by equipment must be available within 24 hours for emergencies, breakdowns and whenever equipment is out of service for maintenance.

Table #1 shows the average equipment requirements of various sanitary landfills. It should be noted that this table is only a general guide. Equipment requirements will vary according to local conditions.

Another situation which requires consideration is that of compaction. Compaction requirements may depend upon land use after closing of the landfill site or upon availability for future landfill. It is generally accepted that if densities increase, less volume for refuse disposal is required, and thus less land is required. Table #2 shows different densities achieved in test conditions with various types of equipment.

Disposal of bulky items (e.g. automobiles, refrigerators, etc.) should be considered. Different machines have different abilities to crush or pulverize large items.

In selecting the equipment for the type of operation to be followed, the performance of the machine is to be considered. Table #3 shows equipment performance in general.

Soil conditions may change equipment requirements. In light soils most equipment can be used for various duties. In heavy types of soils, larger equipment may be required or the selection of equipment more suited to excavation may be required in the smaller landfill operations.

Slope conditions of the working face may dictate equipment used or the type of wheels or tracks required. Equipment abilities have been previously mentioned.

Weather conditions also can have an effect upon equipment requirement. Areas of heavy rainfall may require equipment more suited to wet conditions.

Frost will have an effect on equipment choice depending on winter operations.

Once selection has been made of the equipment to be purchased, determining individual makes and models is the next step.

Selection of a particular machine may depend upon cost, size, and suitability to individual need.

In most cases a specification sheet is written, and the choice is made of those machines which are within specification limits.

Cost (see Table #4 for average costs)

Cost of equipment, it must be remembered, is not based on initial cost but overall cost. This includes operating and maintenance costs and resale value as well as initial cost.

Some machines have a higher initial cost, but require less maintenance and resale value may be higher, or initial cost may be lower with maintenance being higher and resale value lower.

Suitability

Various makes and models differ in operation and attachments. Where one make or model will not fit the requirements another of the same type may. Equipment varies as much as individual needs.

Size

Equipment is generally varied in size, but some equipment dealers offer limited variety. Because of this certain makes may be eliminated because of size restrictions.

Table #1

| +Population | Daily Tonnage | No. of Pieces | Type | Equipment Weight | Equipment Horsepower |
|---|---|---|---|---|---|
| 0 - 7,500 | 0 - 20 | 1 only | C.D. | <15.000 | <80 |
| | | | C.L. | <20,000 | <70 |
| | | | R.T.L. | <20,000 | <100 |
| | | | S.W.C. | N/A | N/A |
| 7,500 - 18,000 | 20 - 50 | 1 only | C.D. | 15,000 - 20,000 | 80 - 110 |
| | | | C.L. | 20,000 - 25,000 | 70 - 100 |
| | | | R.T.L. | 20,000 - 22,500 | 100 - 120 |
| | | | S.W.C. | Smallest Available | |
| 18,000 - 47,000 | 50 - 130 | 1 only | C.D. | 20,000 - 25,000 | 110 - 130 |
| | | | C.L. | 25,000 - 32,500 | 100 - 130 |
| | | | R.T.L. | 22,500 - 27,500 | 120 - 150 |
| | | | S.W.C. | As Available | 150 |
| 47,000 - 91,000 | 130 - 250 | 1 only | C.D. | 30,000 - 35,000 | 150 - 180 |
| | | | C.L. | 32,500 - 45,000 | 150 - 190 |
| | | | R.T.L. | 27,500 - 35,000 | 150 - 190 |
| | | | S.W.C. | 30,000 - 42,000 | 150 - 190 |
| 91,000 - 182,000 | 250 - 500 | 1 - 2 | C.D. | 47,500 - 52,000 | 250 - 280 |
| | | | | Combination | |
| | | | | Combination | |
| | | | | Combination | |
| | | | S. | | |
| | | | D.L. | | |
| | | | W.T. | | |
| 182,000 plus | 500 plus | 2 or more | C.D. | Combination of Equipment | |
| | | | C.L. | | |
| | | | R.T.L. | | |
| | | | S.W.C. | | |
| | | | S. | | |
| | | | D.L. | | |
| | | | R.G. | | |
| | | | W.T. | | |

+ Population based upon 5 1/2 pound per person (table based upon tonnage)
C.D. - Crawler Dozer
C.L. - Crawler Loader
R.T.L. - Rubber Tired Loader
S.W.C. - Steel Wheeled Compactor
S. - Scraper
D.L. - Dragline
W.T. - Water Truck
R.G. - Road Grader

# TABLE 2.
# COMPACTION OF EQUIPMENT COMPARISON

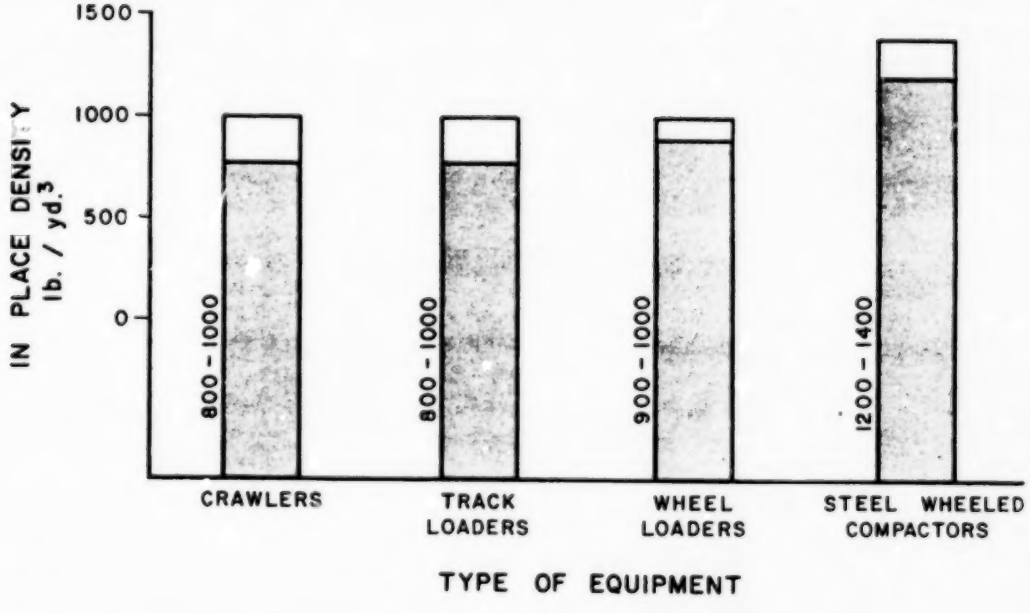


Table #3

| Equipment | Solid Waste | | Excavate | Cover Material | | Haul |
|---|---|---|---|---|---|---|
| | Spread | Compact | | Spread | Compact | |
| Crawler Dozer | E | G | E | G | G | N/A |
| Crawler Loader | G | G | E | G | G | N/A |
| Rubber-Tired Dozer | E | G | G | G | G | N/A |
| Rubber-Tired Loader | G | G | F | G | G | N/A |
| Landfill Compactor | E | E | *P to F | G | *G to E | N/A |
| Scraper | N/A | N/A | G | E | N/A | E |
| Dragline | N/A | N/A | E | F | N/A | N/A |

* Depends Upon Equipment

NOTE: Easily workable material and Haul distance over 1000 feet

(E-excellent, G-good, F-fair, P-poor, N/A-not applicable)

Table #4

Equipment Cost Estimates

| Machine Type | Flywheel Horse Power | *Approximate Average Weight (lb.) | +Approximate Average Cost ($) |
|---|---|---|---|
| Crawler Dozer | 50-100 | 15,000 lb. | $ 53,000 |
| | 100-150 | 31,000 lb. | $110,000 |
| | 150-200 | 41,000 lb. | $145,000 |
| | 200-250 | 51,000 lb. | $170,000 |
| | 250-300 | 70,000 lb. | $200,000 |
| Crawler Loader | 50-100 | 20,000 lb. | $61,500 |
| | 100-150 | 33,000 lb. | $111,000 |
| | 150-200 | 48,000 lb. | $165,000 |
| | 200-250 | -- | -- |
| | 250-300 | 80,00 lb. | -- |
| Rubber-Tired Loader | 50-100 | 17,000 lb. | $ 75,000 |
| | 100-150 | 24,000 lb. | $ 93,000 |
| | 150-200 | 33,000 lb. | $134,000 |
| | 200-250 | 40,000 lb. | $180,000 |
| | 250-300 | 51,500 lb. | $220,000 |
| Steel Wheeled Compactor | 150-200 | 40,000 lb. | $155,000 |
| | 200-250 | -- | -- |
| | 250 plus | 60,000 lb. plus | $250,000 plus |

*Weights - The average of known equipment weights within range given

+Cost - is average of known basic list prices within range given

Note: Costs obtained March, 1980 - F.O.B. Edmonton